REMARKS

In response to the Office Action mailed October 8, 2003, Applicant has amended the application as above. No new matter is added by the amendments as discussed below. Applicant respectfully requests the entry of the amendments and reconsideration of the application in view of the amendments and the remarks set forth below.

Discussion of Specification and Claim Amendments

The specification has been amended to correct technical errors or to clarify the original disclosure. No new matter has been added by the specification amendments.

Claims 1, 27 and 47 have been amended. Claims 79-85 have been added. Claims 53-78 have been cancelled without prejudice. Upon the entry of the amendments, Claims 1-52 and 79-85 are pending in this application. The amendments to Claim 1 are supported by, for example, the specification at page 6, lines 9-10 and Figure 5. The amendments to Claims 27 and 47 are merely for clarification and do not narrow the scope of protection. New Claims 79-85 are supported by, for example, Figure 5 and the specification at page 6, lines 9-10 and page 7, lines 6-8. Thus, no new matter is added by the claim amendments. Applicant respectfully requests the entry of the amendments.

Discussion of Specification Objections

The Examiner has objected to the disclosure because of some informalities. As discussed below, the objected disclosure is now clear. Withdrawal of the objections is respectfully requested.

The Examiner notes that on page 1, line 19, "connecting to a" should be "connections to." In reply, Applicant has amended the language accordingly. The Examiner notes that on page 5, line 14, "combination" should be "combinations." The Examiner also notes that on page 11, line 13, "diffenrece" should be "difference." In reply, Applicant has amended the terms accordingly.

The Examiner asserts that on page 2, line 15, "interconnects" should be "interconnect." In reply, Applicant has amended the language to read "copper interconnects 12" since the "copper interconnects 12" refer to a plurality of copper interconnects as shown in Figure 1.

The Examiner notes that on page 10, line 17, "that a bond pad tae" is not a clear statement." In reply, Applicant has amended the language to read "on which the bond pad can form."

The Examiner asserts that on page 10, line 30, "that use" should be "that uses." In reply, Applicant has amended the language accordingly.

The Examiner notes that on page 11, passivation "103" in Figure 10A is not mentioned. In reply, Applicant has added the sentence "Reference numeral 103 represents a passivation layer 103" in the relevant portion of the specification.

In addition, Applicant has reviewed the specification and corrected all technical errors that Applicant identified.

Discussion of Claim Objection

The Examiner has objected to Claim 27 because of an informality. The Examiner notes that there are two periods at the end of Claim 27. In reply, Applicant has removed one period from the claim. Claim 27 is now clear. Withdrawal of the objection is respectfully requested.

Discussion of Claim Rejections Under 35 U.S.C. § 102(b)

The Examiner has rejected Claims 1-2, 4-8, 10-11, 13-16, 18, 20-22, 23, 25, 27-33 and 35-38 under 35 U.S.C. § 102(b) as being anticipated by DiGiacomo, *et al.* (U.S. Patent No. 5,266,522).

Standard of Anticipation

"For a prior art reference to anticipate a claim under 35 U.S.C. § 102, every element of the claimed invention must be identically shown in a single reference." *Diversitech Corp. v. Century Steps, Inc.*, 850 F.ed 675, 677, 7 USPQ 2d 1315, 1317 (Fed. Cir. 1988).

Discussion of Patentability of Independent Claims 1, 7 and 16

Claim 1 recites, among other things, applying *a noble metal* on the exposed portion of the metal interconnect, and performing a maskless *chemical process* that converts a layer of the noble metal into *a bondable layer compatible with a wire bonding.* Each of independent Claims

7 and 16 includes a similar limitation. As discussed below, DiGiacomo does not disclose the above-recited features.

1. **DiGiacomo Does Not Disclose Applying a Noble Metal on the Exposed Portion of the Metal Interconnect**

Referring to Figures 1-4, DiGiacomo clearly shows that a chromium (Cr) layer (16) is deposited on a metal interconnect (14). Chromium is not regarded as a noble metal. Examples of a noble metal are Ag, Au, Pd, Pt, Ru, Rh, Re, Os and Ir as recited in dependent Claim 10. Thus, DiGiacomo does not disclose applying *a noble metal* on the exposed portion of the metal interconnect.

Although DiGiacomo discloses a multilayer structure including noble metal layers (17, 20), the layer structure of the DiGiacomo reference is completely different from that of the claimed invention. In the claimed invention, the noble metal is applied on the portion of the exposed metal interconnect. In contrast, in DiGiacomo, the noble metals (17, 20) are deposited on the chromium layer (16) and a nickel layer (18), respectively (Figures 2-4).

Furthermore, DiGiacomo requires the chromium layer (16) and the nickel layer (18) to be part of the multilayer structure. This is because in DiGiacomo the chromium and nickel layers (16, 18) are an important ingredient of the DiGiacomo invention, and the chromium layer (16) forms a strong bond with either the nickel layer (18) or the noble metal layer (17) (column 5, lines 48-53). Furthermore, DiGiacomo discloses that the chromium layer (16) is to ensure adhesion to the substrate (12). In view of the above discussion, Applicant respectfully submits that DiGiacomo does not disclose applying *a noble metal* on the exposed portion of the metal interconnect recited in independent Claims 1, 7 and 16.

2. **DiGiacomo Does Not Disclose Performing a (Maskless) Chemical Process that Converts a Layer of the Noble Metal into a Bondable Layer Compatible with a Wire Bonding**

Referring to column 5, lines 2-4, DiGiacomo discloses that the chromium layer (16) is deposited on the substrate (12), so that it is electrically in contact with the metal interconnect (14). This is simply a physical contact of materials. No chemical process, which converts the

chromium layer (16) into a bondable layer (or other layer) compatible with wire bonding, is performed in connection with the chromium layer (16). Examples of the chemical process are an immersion process, a dip process or an electroless process as recited in dependent Claim 9. In one embodiment of the claimed invention discussed in the specification at page 6, lines 21-23, the chemical process involves an exchange of atoms between the interconnect metal and the noble metal, which results in a layer of the noble metal being formed on the metal interconnect.

In addition, the chromium layer (16) is not converted into a bondable layer in DiGiacomo. Furthermore, the chromium layer (16) would not convert to another layer since the chromium layer (16) is required to form a strong bond with either the nickel layer (18) or the noble metal layer (17) as discussed above. In view of the above, Applicant respectfully submits that DiGiacomo does not disclose performing a (maskless) *chemical process* that converts a layer of the noble metal into *a bondable layer compatible with a wire bonding.*

3. Summary

In view of the above, Applicant respectfully submits that DiGiacomo discloses neither the applying a noble metal on the exposed metal interconnect nor the performing a (maskless) chemical process that converts a layer of the noble metal into a bondable layer compatible with a wire bonding recited in Claims 1, 7 and 16.

Discussion of Patentability of Independent Claim 23

Claim 23 recites, among other things, forming a layer of *a low melting point metal* whose melting temperature is relatively low on the exposed portion of the metal interconnect and *converting the layer of the low melting point metal into a bondable layer* compatible with a wire bonding *by a chemical process*. However, as discussed below, DiGiacomo does not disclose the above-recited features.

1. DiGiacomo Does Not Disclose Forming a Layer of a Low Melting Point Metal on the Exposed Portion of the Metal Interconnect

Referring to Figures 1-4, DiGiacomo clearly shows that a chromium (Cr) layer (16) is deposited on a metal interconnect (14). Chromium is not regarded as a low melting point metal.

Examples of a low melting point metal are Sn, In, Bi and Pb as recited in dependent Claim 59. Thus, Applicant respectfully submits that DiGiacomo does not disclose forming a layer of the low melting point metal on the exposed portion of the metal interconnect recited in Claim 23.

2. DiGiacomo Does Not Disclose Converting the Layer of the Low Melting Point Metal into a Bondable Layer Compatible with a Wire Bonding by a Chemical Process

As discussed above with regard to patentability of independent Claims 1, 7 and 16, nothing related to conversion of the chromium layer (16) into a bondable layer or any other layer occurs on the multilayer structure of DiGiacomo. In addition, the chromium layer (16) would not convert to another layer since the layer (16) is an essential layer of DiGiacomo as discussed above. Furthermore, DiGiacomo does not disclose any chemical process with regard to the conversion of the chromium layer (16) into a bondable layer or other layer as discussed above.

3. Summary

In view of the above, Applicant respectfully submits that DiGiacomo discloses neither the applying a low melting point metal on the exposed metal interconnect nor the converting the layer of the low melting point metal into a bondable layer compatible with a wire bonding by a chemical process recited in Claim 23.

Discussion of Patentability of Independent Claim 32

Claim 32 recites, among other things, applying *a low melting point metal* whose melting temperature is relatively low on the exposed portion of the metal interconnect and *converting a layer of the low melting point metal into a bondable layer* compatible with a wire bonding on the exposed portion of the metal interconnect. However, as discussed below, DiGiacomo does not disclose the above-recited features.

As discussed with regard to patentability of independent Claim 23, DiGiacomo does not disclose applying a layer of a low melting point metal on the exposed portion of the metal interconnect. In addition, DiGiacomo says nothing about conversion of the chromium layer (16) into a bondable layer or any other layer.

In view of the above, Applicant respectfully submits that DiGiacomo discloses neither

the applying a low melting point metal on the exposed metal interconnect nor the converting the layer of the low melting point metal into a bondable layer compatible with a wire bonding recited in Claim 32.

Summary

As discussed above, DiGiacomo does not show every element of each of independent Claims 1, 7, 16, 23 and 32. Applicant respectfully submits that DiGiacomo does not anticipate Claims 1, 7, 16, 23 and 32. Furthermore, since DiGiacomo does not teach or suggest the recited features of the claimed invention, each of the independent claims would not have been made obvious over the reference, either. Therefore, independent Claims 1, 7, 16, 23 and 32 are patentable over DiGiacomo.

Claims 2, 4-6, 8, 10-11, 13-15, 18, 20-22, 25, 27-31, 33 and 35-38 depend from base Claim 1, 7, 16, 23 or 32, and further define additional technical features of the present invention. In view of the patentability of their base claim, and in further view of their additional technical features, the dependent claims are patentable over the cited reference. Withdrawal of the rejections is respectfully requested.

Discussion of Claim Rejections Under 35 U.S.C. § 103(a)

The Examiner has rejected Claims 3, 9, 12, 17, 19, 24, 26 and 34-52 under 35 U.S.C. § 103(a) as being unpatentable over DiGiacomo in view of Pace (U.S. Patent Application Publication No. 2003/0124829) further in view of Eldridge, *et al* (U.S. Patent No. 6,110,823). However, all of the rejected claims are patentable over the cited references as discussed below.

Standard of *Prima facie* Obviousness

In order to provide a *prima facie* showing of obviousness under 35 U.S.C. § 103, all the claim limitations must be taught or suggested by the prior art. *See, e.g., In re Royka,* 490 F. 2d 981, 180 U.S.P.Q. 580 (CCPA 1974); MPEP 2143.03. Alternatively, in order to provide a *prima facie* showing of obviousness, the U.S. Patent and Trademark Office has the burden to show a motivation, teaching, or suggestion to cause one of ordinary skill in the art to make the

modification or combination asserted by the Examiner to be obvious. *See, e.g., In re Fine*, 5 U.S.P.Q.2d 1597 (Fed. Cir. 1988).

Patentability of Independent Claims 39 and 47

Claim 39 recites, among other things, forming a layer of solder particles of a low melting point metal whose temperature is relatively low on the exposed portion of the metal interconnect and converting the layer of the solder particles into a bondable layer compatible with a wire bonding. Claim 47 recites, among other things, forming a layer of fine particles of a noble metal on the exposed portion of the metal interconnect and converting the layer of the fine particles into a bondable layer compatible with a wire bonding.

That is, the claimed invention with regard to Claims 39 and 47 is directed to forming a layer of a low melting point metal or a layer of a noble metal on the exposed portion of the metal interconnect and converting the low melting point metal layer or the noble metal layer into a bondable layer compatible with a wire bonding.

1. None of DiGiacomo, Pace and Eldridge Teach or Suggest Converting the Noble Metal Layer or the Low Melting Point Metal Layer into a Bondable Layer Compatible with a Wire Bonding

As discussed above, DiGiacomo does not disclose, teach or suggest conversion of either the noble metal layer or the low melting metal layer into a bondable layer compatible with a wire bonding. DiGiacomo does not even disclose either the noble metal or the low melting point metal itself as discussed above.

Pace does not teach or suggest converting the low melting point metal layer or the noble metal layer into a bondable layer compatible with a wire bonding. Pace is directed to forming metal bumps (130), on a substrate (110), which will be connected with the input/output pads of a semiconductor device (140) (paragraph [0010] and [0024], Figure 2). The convex bump metals (130) are formed on the substrate (110) using a conductive pattern ([0024]). The input/output portions of the semiconductor device (140) are joined with the bump metals (130). Nothing regarding conversion of the bump metals (130) into a bondable layer or other layer occurs on the Pace structure. In addition, even if the bump metals (130) may be regarded as a bondable layer,

the bump metals (130) are different from the recited bondable layer *compatible with a wire bonding*. This is because the convex bump metals (130) are for connecting with the input/output pads of the semiconductor device (140) and not compatible with a wire bonding.

Eldridge does not teach or suggest converting the low melting point metal layer or the noble metal layer into a bondable layer compatible with a wire bonding. Referring to column 27, lines 56-59 and Figure 1C, a conductive layer (126) such as aluminum is deposited on a passivation layer (124). Thereafter, a wire (102) is bonded to the conductive layer (126). This is one of conventional wire bonding processes as discussed in the Related Technology section of this application (see page 2, lines 11-23 and Figure 1). No conversion of the conductive layer into a bondable layer occurs on the Eldridge structure. Although Eldridge discloses that other metals such as gold, silver or platinum (noble metal) can be used as the conductive layer (126) (column 55, lines 44-49), nothing regarding conversion of the conductive layer (126) into a bondable layer or other layer occurs on the Eldridge structure.

In view of the above discussion, none of DiGiacomo, Pace and Eldridge teach or suggest converting the low melting point metal layer or the noble metal layer into a bondable layer compatible with a wire bonding.

2. No Motivation to Combine DiGiacomo, Pace and Eldridge to Arrive at the Claimed Invention Exists

DiGiacomo is directed to a multilayer structure including a chromium layer (16), a noble metal layer (17), a nickel layer (18) and a noble metal layer (20). DiGiacomo also discloses that i) the chromium and nickel layers (16, 18) are an important ingredient of the DiGiacomo invention, ii) the chromium layer (16) would not separate from either the noble metal layer (17) of the nickel layer (18) and iii) the chromium layer (16) is to ensure adhesion to the substrate (12) (column 5, lines 48-53 and 59-60).

Pace discloses that low melting point metals or noble metals can be used as the bump metals (130) ([0021], [0023]). Eldridge discloses that the conductive layer (126) such as gold, silver or platinum (noble metal) is deposited on the passivation layer (124), and thereafter the wire (102) is bonded to the conductive layer (126).

As discussed above, the chromium metal belongs to neither the noble metals nor the low melting point metals. In addition, DiGiacomo discloses that the chromium layer (16) is an essential layer of the DiGiacomo invention as discussed above. Furthermore, no substitute metal of the chromium has been provided in DiGiacomo. A skilled person in the art would have no reason to change the chromium layer to other layer. Thus, Applicant respectfully submits that there is no motivation to modify the DiGiacomo multilayer such that the chromium layer (16) is replaced with a noble metal or a low melting metal of Pace. Similarly, Applicant respectfully submits that there is no motivation to modify the DiGiacomo multilayer such that the chromium layer (16) is replaced with the conductive layer (126) of Eldridge.

The Examiner asserts that motivation to combine DiGiacomo and Pace exists because Pace teaches that forming the bump metals (130) on the substrate (110) by electroplating or gold plating is conventional. The Examiner also asserts that motivation to combine DiGiacomo and Eldridge exists because Eldridge teaches that gold is often the top metal.

Applicant respectfully disagrees with the Examiner in this regard. The mere fact that the references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680, 16 USPQ 2d 1430 (Fed. Cir. 1990). MPEP 2143.01. Neither Pace nor DiGiacomo provides the desirability of the combination to arrive at the claimed invention. In addition, neither Eldirdge nor DiGiacomo provides does the desirability of the combination to arrive at the claimed invention.

3. The Proposed Modification Would Render the Prior Art Invention Unsatisfactory for Its Intended Purpose

If a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. MPEP 2143.01. Even if Digiacomo can be modified to combine with either Pace or Eldridge, the modified structure would be unsatisfactory.

As discussed above, in DiGiacomo the chromium layer (16) is an essential layer to perform its intended purpose (providing corrosion- and stress-resistant interconnect). Thus, if either i) a noble metal (a low melting point metal) of Pace or ii) the noble metal (Ag, Au,

Platinum) of Eldridge is replaced with the chromium layer (16) of DiGiacomo, the modified DiGiacomo structure would be unsatisfactory for its intended purpose.

4. Advantages of Embodiments of the Claimed Invention

A wire bonding on a bare Cu chip is a back end or assembly house issue. In the prior art, the process could only be carried out in a semiconductor chip fabrication house, which uses a costlier sputtering and etching tool. The prior art involves sputtering an aluminum layer on copper, and then carrying out the passivation and sending it to assembly houses for wire bonding. However, in one embodiment of the claimed invention the same process is carried out on a bare Cu chip which has already been sent to the assembly house. It is a simple chemical process which converts the exposed copper layer into a bondable layer, thus permitting a wire bonding using conventional Au and Al wire bonders (page 10, lines 5-13).

In another embodiment of the claimed invention, the process affects only the exposed copper interconnects (43), and hence no mask is required. The noble metal is restricted to adhere only to the Cu interconnects (42), even if masks are not used, because an exchange reaction of atoms does not occur on the passivation layer (45). Even if most of the back end houses are generally not equipped with photolithographic equipment and masks, the process of the invention is very conveniently performed at either a front end or a back end (page 7, lines 5-11).

The main purpose of DiGiacomo is to form a multilayer structure for solder bumping and it is not related to wire bonding. The main purpose of Pace is to form conductive bumps by plating method for flip chip interconnection. The main purpose of Eldridge is to form spring interconnections on a semiconductor device.

Applicant respectfully submits that none of DiGiacomo, Pace and Eldridge provide these advantages. DiGiacomo discloses that the multilayer structure is deposited by chemical vapor deposition, etching, evaporation or sputtering (column 4, lines 46-50). Pace discloses in paragraph [0024] that the bump metals (130) are formed by a conductive pattern, which generally requires a mask. Eldridge discloses that the layer structure is formed using a photoresist (128) (Figures 1C and 1D). That is, the prior art references generally require additional steps using a mask or a photoresist.

5. Summary

In view of the above, none of the prior art references teach or suggest all of the claim limitations. In addition, there is no evidence of any suggestion that one of ordinary skill in the art would be motivated to combine DiGiacomo, Pace and Eldridge to arrive at the claimed invention. Therefore, Applicant respectfully submits that the U.S. Patent and Trademark Office has failed its burden to provide clear and particular evidence showing a motivation, teaching, or suggestion to cause one of ordinary skill in the art to fuel the claimed invention to be obvious. Therefore, absent any evidentiary sources of motivation, teaching, or suggestion, no proper *prima facie* showing of obviousness can be set forth. Therefore, Applicant respectfully submits that the claimed invention with regard to independent Claims 39 and 47 is patentable over the references of record. Withdrawal of the rejections is respectfully requested.

Patentability of Dependent Claims

Claims 40-52 depend from base Claim 39 or 47, and further define additional technical features of the present invention. In view of the patentability of their base claim, and in further view of their additional technical features, the dependent claims are patentable over the cited reference.

Claims 3, 9, 12, 17, 19, 24, 26 and 34-38 depend from base Claim 1, 7, 16, 23 or 32, and further define additional technical features of the present invention. As discussed above, independent Claims 1, 7, 16, 23 and 32 are patentable over DiGiacomo. For at least a similar reason to patentability of Claims 39 and 47 over DiGiacomo, Pace and Eldridge, independent Claims 1, 7, 16, 23 and 32 are patentable over DiGiacomo, Pace and Eldridge. Therefore, the dependent claims of independent Claims 1, 7, 16, 23 and 32 are patentable over all of the cited references. Withdrawal of the rejections is respectfully requested.

Discussion of Patentability of New Claims 79-85

New Claims 79-85 depend from base Claims 1, 7, 16, 23, 32, 39 and 47, and further define additional technical features of the present invention.

Particularly, each of Claims 79, 81, 83 and 85 recites that the noble metal or the low melting point metal is a single metal. Even if the entire mulitilayer of DiGiacomo can be regarded as the claimed bondable layer, the entire multilayer is not a single metal. In addition, each of Claims 80,

82 and 84 recites that the remaining portion of the metal interconnect is covered by a passivation layer. DiGiacomo does not show this feature. Referring to Figures 1-4 of DiGiacomo, the entire metal interconnect (14) is covered by the chromium layer (16).

In view of the patentability of their base claims, and in further view of their additional technical features, new Claims 79-85 are patentable over the cited references.

CONCLUSION

In view of Applicant's amendments to the claims and specification and the foregoing remarks, it is respectfully submitted that the present application is in condition for allowance. Should the Examiner have any remaining concerns which might prevent the prompt allowance of the application, the Examiner is respectfully invited to contact the undersigned at the telephone number appearing below.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: 1/8/04

By: _____

John M. Carson
Registration No. 34,303
Attorney of Record
Customer No. 20,995
(619) 235-8550

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